PSYCHO-PHYSICAL SURVEY OF THE PUPILS OF THE PERKINS INSTITUTION FOR THE BLIND

Kathryn E. Maxfield

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PSYCHO-PHYSICAL SURVEY OF THE PUPILS OF THE PERKINS INSTITUTION FOR THE BLIND.

Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Arts, in the Faculty of Philosophy,
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By

KATHRYN E. MAXFIELD

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PSYCHO-PHYSICAL SURVEY OF THE PUPILS OF THE PERKINS INSTITUTION FOR THE BLIND.

Introduction

About thirty years ago Porter (11) made the first important survey to determine relationship between physical measurements and mental ability. Using grade and age as his standards of mental ability, he decided that the accelerated in school were also accelerated in physical growth. Christopher (2) and Smedley (13) confirmed his results, concluding that there was a constant correlation between standing in physical measurements and mental ability. Others whose investigations led them to agree with these results were MacDonald (10), De Busk (3), Beyer (1), Kline (9), Gratsianoff (8), and Sack (12). Doll (4), working more recently, in the Training School at Vineland, found quite a definite relationship between degree and kind of feeble-mindedness, and physical inferiority. The chief investigator to obtain results opposed to these is Gilbert (6) and (7), in his work on New Haven school children, and on Iowa school children and college students. The consensus of opinion seems to be, however, that with the average run of public school children, there is a definite and constant correlation between physical development, especially grip and lung capacity, and mental ability. A recent study by Garrison and Pullias (5) furnishes still more positive evidence along this line.

This is merely a suggestion of the work that has been done but a full bibliography on the subject can be found in Whipple's Manual (15). For this survey of The Perkins Institution, Doll's

method of obtaining and treating results has been followed more closely than any other. At present, there is no means of determining whether or not the results of the tests upon the 263 blind children and young people here is fairly representative of the state of affairs in the blind population at large, although no significant mental or educational differences were discovered in the survey of ten schools for the blind, by Hayes and his assistants, in 1919-1920.

In schools for the blind, like the Perkins Institutions, the feeling is often expressed by the teachers that they have more than their share of pupils whose accomplishment ability is noticeably inferior to their general intelligence as judged by the Irwin-Binet tests. It has been thought that the chief reason for this is probably inherited physical inferiority, because there are so many here who come from the less efficient classes of society. Bad home environment has undoubtedly played its part, too. So many parents either overwhelm their blind children with ill-advised kindness, or else utterly neglect them. Yet it has been impossible not to feel that a child's intelligence level must influence to some degree his willingness to submit to an inert existence, and thus, also, affect his accomplishment in school. Consequently, when it was necessary to test the whole school for standing height, weight, and lung capacity, the opportunity was seized to obtain a complete psycho-physical survey. Acknowledgment is gratefully made of the valuable assistance given by Dr. Samuel P. Hayes of Mount Holyoke College.

Apparatus and Method

Psycho-physical measurements were first made at the Perkins Institution some six years ago by Miss Edith Taylor, who had used them under Dr. Doll at Vineland. Most of the apparatus needed for the survey was, therefore, already at hand.

Stadiometer.

The Narragansett Machine Co. stadiometer is particularly well adapted for a survey of this sort. The rod is set on a box fifteen inches high. This makes it possible to take sitting height with the least expenditure of time. The rod is also fitted with a cross-beam, which is brought down until it gently touches the top of the subject's head. The scale is graduated both by centimeters and by inches. For standing height, the subject stands on the box, as straight as possible, heels together against the rod. The pupils were not asked to remove their shoes, because it had been found that the height of heel was fairly constant. Doll considered that there might be a constant plus error of about 1 cm., in his tests at Vineland. The plus error here is more nearly 2 cm.

Scales.

For weight, a two-beam scale, marked to tenths of pounds and twentieths of kilograms was used. The subjects were weighed with their clothing on. According to Baldwin, this involves a constant error of approximately .75 kgs. for children under twelve, and 1.1 kg. for those over twelve years of age. These results would be comparable with Smedley's, since he took weight measurements without having the subjects remove their clothes.

Dynamometer

The right and left grip were found with the Smedley dynamometer, which is adjustable to the sixe of the subject's hand. The movable stirrup was regulated so as to bring the innər edge as nearly to the second joint of the fingers as possible, when the outer edge was pressed against the base of the thumb. In the cases of some of the younger or the less competent pupils it was necessary for the examiner to hold the back of the instrument, carefully. It proved very interesting to watch the various methods used by the pupils in their efforts to raise their score. The subject was given three trials with each hand, alternating right and left, the highest result for each being considered his score.

Spirometer

The Stoelting wet-spirometer was used for testing lung or vital capacity. Differences of five cubic inches are the smallest that are indicated on this spirometer, but this is accurate enough for all practical purposes. The measurements were changed to cubic centimeters, to make them comparable with Smedley's results. Although the term "lung capacity" is generally used in this paper, what is really tested is the "vital capacity", since there is always a residuum of air left in the lungs, which cannot be expelled. The pupils were allowed three trials, the best of the three being recorded as the score. With this and with the dynamometer test,it was often necessary to let the subject experiment a little, before the actual measurements were made, because the younger or more backward pupils did not always grasp the idea from being told. They could not profit by watching someone else do the tests, and so had to discover how by trial and error.

Treatment of Data

The entire school was so interested in these tests that the results probably represent the best efforts of all the pupils. A sample of the individual record blank is found on page 9.These had been modeled by Miss Taylor after the ones used by Doll at Vineland. The percentile tables worked out by Fred Warren Smedley, in Chicago, and published in Child-Study Report No. 3, have been used in this report as the basis for comparing the blind students here with the average outsider of the same age and sex. This Child-Study Report, issued by the Department of Child-Study and Pedagogic Investigation of the Chicago Public Schools, is now out of print, and so the liberty is taken of quoting from Doll's Anthropometry as an Aid to Mental Diagnosis. Doll quotes from the report as follows:

"Tables have thus been produced which will be of especial service in the Child-Study Laboratory and of value to all who make a study of individual children. By means of these tables one can determine closely how a given child compares with others of his age. These percentiles have been obtained in the following manner: The individual cards on which the measurements were recorded when the child was tested were arranged according to the size of the pupils in each measurement, grouped separately for each age in years. The minimum measurement in each such group gave the zero percentile for that group. To determine the ten percentile for that group, ten percent of the number of cards was removed, beginning at the minimal end, and the highest measurement on the cards so removed was recorded as the maximum measurement being recorded as the one hundred percentile."

Then Doll goes on to say, that "To derive a comparison percentile from the numerical tables one refers to the proper table for age and sex, and there, by inspection and a simple method of interpolation, finds the exact position of the individual in each measurement on the scale of 100. Specifically, to find the exact interpolated percentile of any measurement: first, find the table corresponding to the subject's sex, and to his age at the last birthday; second, for each measurement find the two percentiles of the table between which the given measurement lies; subtract the value of the lower limiting percentile from the given measurement; fourth, divide this difference by the difference between the values of both limiting percentiles; fifth, multiply this decimal by 10 (the difference between the two percentiles) and add to the lower limiting percentile.

"For the treatment of values above the 100-percentile we have assumed the difference between the 90-percentile valud and the 100-percentile value (for each table and measurement) to be constant, applying equally to hypothetical percentile groups beyond the 100-percentile; similarly for values falling below the 0-percentile value we have assumed the difference between the 10-percentile value and the 0-percentile value to be constant, operating equally to successive hypothetical percentile groups below 0. Thus, to determine the percentile for a value which lies beyond the highest limit of a table, subtract the 100-percentile value from the given value, divide this difference by the difference between the 90-percentile value and the 100-percentile value, multiply this quotient by 10 and add the result to 100. Similarly, for a value which lies below the lowest limit of a table, subtract the 0-percentile value algebraically from

the given value, divide this difference by the difference between the 0-value and the 10-value, multiply by 10 and add to 0, retaining the algebraic sign. This method is obviously open to error, but seems superior to other methods which have suggested themselves. The error is probably not great, and such as it is operates in favor of the compared value, since the difference between values for the successive percentiles increases geometrically rather than arithmetically as the percentile lies farther above or below 50, the median.

"To relate these derived percentiles to each other graphically they may be plotted on graph sheets in which the separate measurements are represented along the abscissae and the percentiles along the ordinates of artifically constructed co-ordinate points.*******

"To graph the percentiles of the measurements, place a point on the graph sheet midway in the space for each measurement at a height corresponding to the computed percentile for that measurement. To draw the "curve" connect successive points by straight lines from left to right. To draw the "slope" for the curve, average the first three percentiles (physical), and the second three (psycho-physical); locate the physical average as an ordinate in the space for sitting height, and the psycho-physical average as an ordinate in the space for left grip. Connect these points by a straight line.

"The age for which each measurement is most nearly average may be found by seeking the age-tables (for the sex) in which the measurements most closely approximate the 50-percentile, which may be considered the average (more exactly, the median) for each age." (In the case of the girl whose record is given on page 9, the standing height is most nearly average for twelve years, but is even then

only at the 14-percentile. Sitting height and weight are most nearly average for age thirteen. Those three averaged, give the age at which the child's curve is most nearly normal, which is age thirteen, in this instance.)

Except for the twenty-five or twenty-six pupils who were within less than two months of their next birthday, age has been figured from the last birthday, as Smedley and Doll did. Correlations for the girls have not been figured because we found no significant ones for the boys. It seemed certain that the girls, with their lesser amount of physical exercise, would not furnish correlations of any more value.

PERKINS INSTITUTION AND MASSACHUSETTS SCHOOL FOR THE BLIND

DEPARTMENT OF RESEARCH

Report on	~~Mental Age~~
Born 1/30/05	Examined 5/1922
Admitted 4/24/11	By RCo

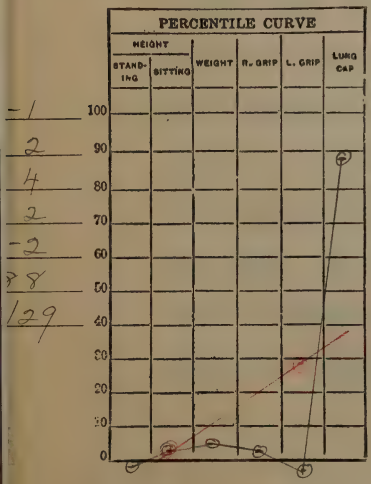
REMARKS

MEASUREMENTS

HEIGHT standing	142.8	c. m. 56.2 in.	GRIP right	15, 16, 12	kg.	lb.
" sitting	78.5	" 30.8. "	" left	11, 10, 11	"	"
WEIGHT	38.7	kg. 85.4 lb.	LUNGS capacity	2788	c. c. 170 170 150	cu. in.

(Psycho-physical curve for child's present age 17.5).

(This child's psycho-physical curve drawn for a child of age 13).



EXPLANATION of DIAGRAM to the LEFT

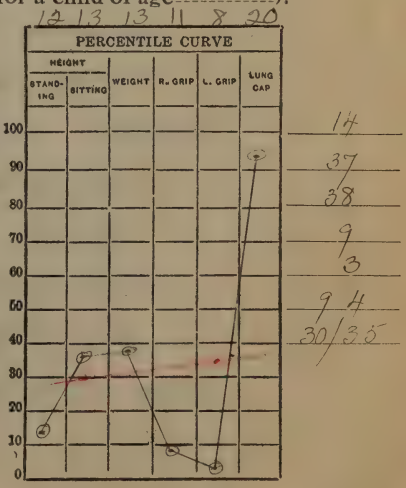
The irregular line drawn across the printed form is called an anthropometric "curve." It shows how this child compares with a large group of children of his own age (and sex), in the various measurements given at the top of the diagram.

The figure at the left of the horizontal line that is crossed by the "curve" shows that the child is as good as that per cent. of normal children of his age and sex in the measurements given at the head of the respective columns.

For example this child is as good as -1 per cent. of h~~is~~er age, in standing height: 2 per cent. in sitting height 4 per cent. in weight, etc.

EXPLANATION of DIAGRAM to the RIGHT

On this diagram a similar curve is drawn for the age at which this child would be normal in height and weight. In other words this child's measurements would be "normal" for a 13 year old child.



Average Results

In 1890, Mr. E. E. Allen, our Director, who was at that time in charge of the School for the Blind at Overbrook, used the Sargent chart to see how the pupils there compared with the average of their sex and age, in standing height, weight and lung capacity. Mr. Allen's results seemed to indicate that on the average, the blind were below the seeing in physical development. Since that date, physical education has been widely introduced into the schools for the blind. It was thought worth while to find the averages for these three measurements, in connection with this survey, to see if any change had occurred in the level of physical development. Taking the Smedley tables as standard, instead of the Sargent ones, the pupils at Perkins Institution apparently test close to normal, physically. (See Tables I and II.) But this result is so far contrary to what observation would lead one to expect, that it led to an inspection of the distribution of measurements. This soon showed that the average was not a true indication of the real state of affairs. The frequency tables, (Table III), show that a great many individuals are far from average attainment. It can also be seen, by a glance at these tables, that the median would be no more fair a method of judging the measurements. Table IV gives sample distributions which show the chief modes. Including those who fall below the zero percentile, 36% of all the pupils are below the ten percentile in right grip and 35% are below it in left grip. In standing height 19% are below the ten percentile, and in sitting height 27% are below. In weight, 15% are below the ten percentile and 22% are above the eighty-five percentile, making

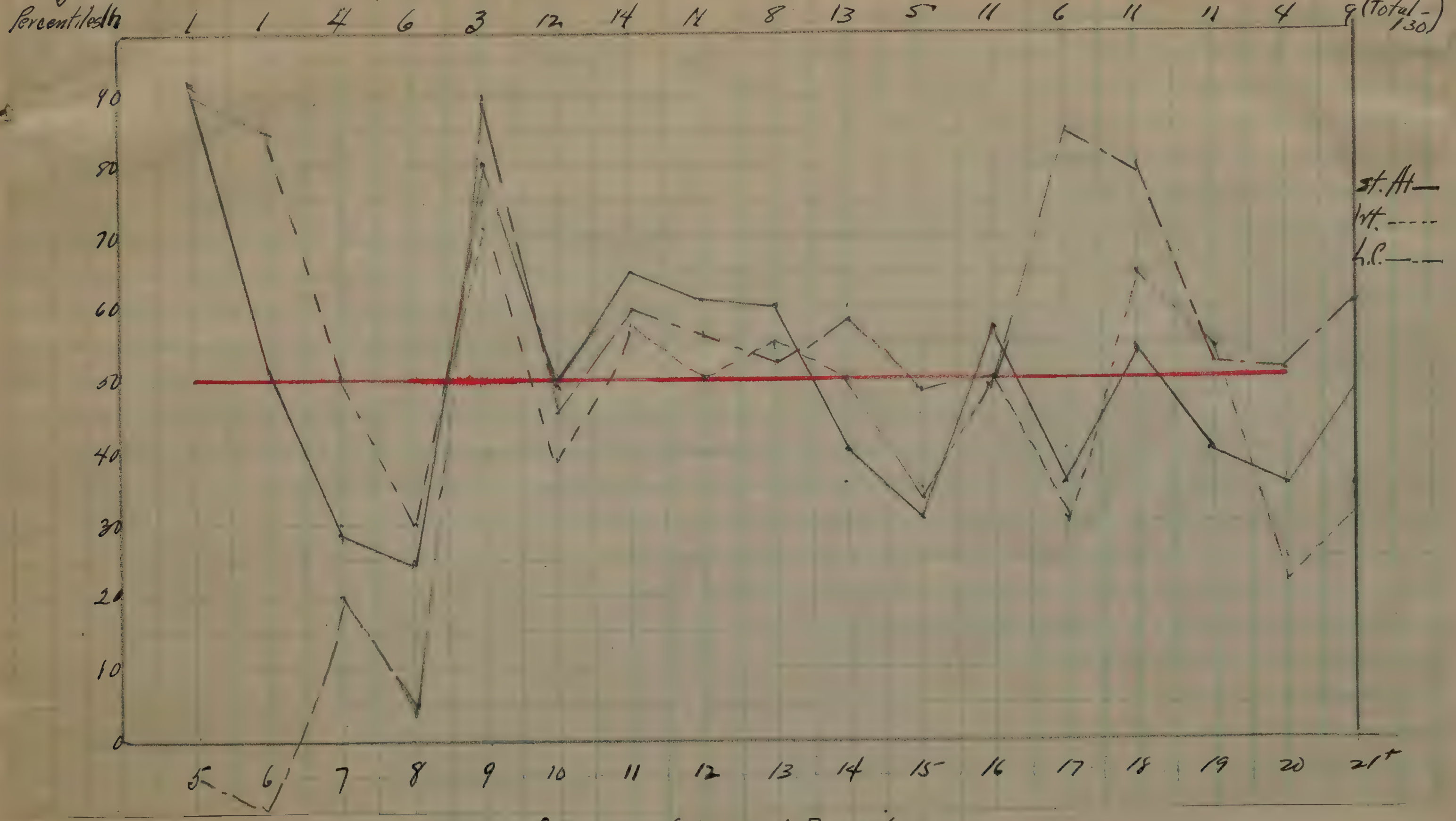
Table I. Average Percentiles for Each Chronological Age Group (Boys)

Age-Group	No	Stand Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Capacity	Phys. Ave.	Ps.-Ph. Ave.
5	1	93	80	90	50	13	-4	88	30
6	1	51	28	85	0	0	-9	55	-3
7	4	29	26	50	35	29	21	35	27
8	6	25	14	30	27	24	4	25	17
9	3	81	53	78	37	38	92	71	56
10	12	48	34	38	12	20	45	41	26
11	14	65	55	58	55	56	59	60	57
12	11	61	54	50	40	48	57	55	50
13	8	60	56	53	49	46	53	57	49
14	13	41	41	52	46	47	58	45	50
15	5	31	31	33	23	37	48	32	34
16	11	57	51	50	49	56	51	48	52
17	6	36	38	31	64	40	83	45	72
18	11	54	46	66	48	53	78	55	58
19	11	40	26	54	47	44	53	41	48
20	4	35	24	22	15	24	52	27	31
21+	9	48	42	33	54	49	60	41	54
Ave. Percentiles for All	130	51	41	50	41	44	57	47	46

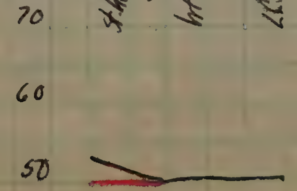
Table II. Average Percentiles for Each Chronological Age-Group (Girls)

Age-Group	No.	Stand Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Capacity	Phys. Ave.	Ps-Ph. Ave
5	2	73	38	94	44	47	32	69	43
6	4	42	26	50	24	23	29	39	26
7	2	64	26	89	22	39	57	60	37
8	4	45	37	53	26	17	47	46	30
9	6	67	56	37	27	35	51	59	37
10	5	63	65	56	54	56	69	61	57
11	7	57	35	45	35	28	57	45	38
12	8	53	53	55	44	38	71	53	51
13	9	33	30	43	22	29	67	36	28
14	7	35	35	48	48	43	69	40	53
15	8	30	17	29	35	42	72	25	49
16	13	57	31	60	36	36	59	47	43
17	12	41	35	54	30	27	86	43	48
18	7	26	31	39	6	3	45	32	18
19	11	44	28	38	19	9	60	37	30
20	7	36	32	63	15	17	71	43	33
21+	21	40	25	57	24	21	53	40	32
Ave Percentiles for All	133	44	26	57	23	22	61	37	32

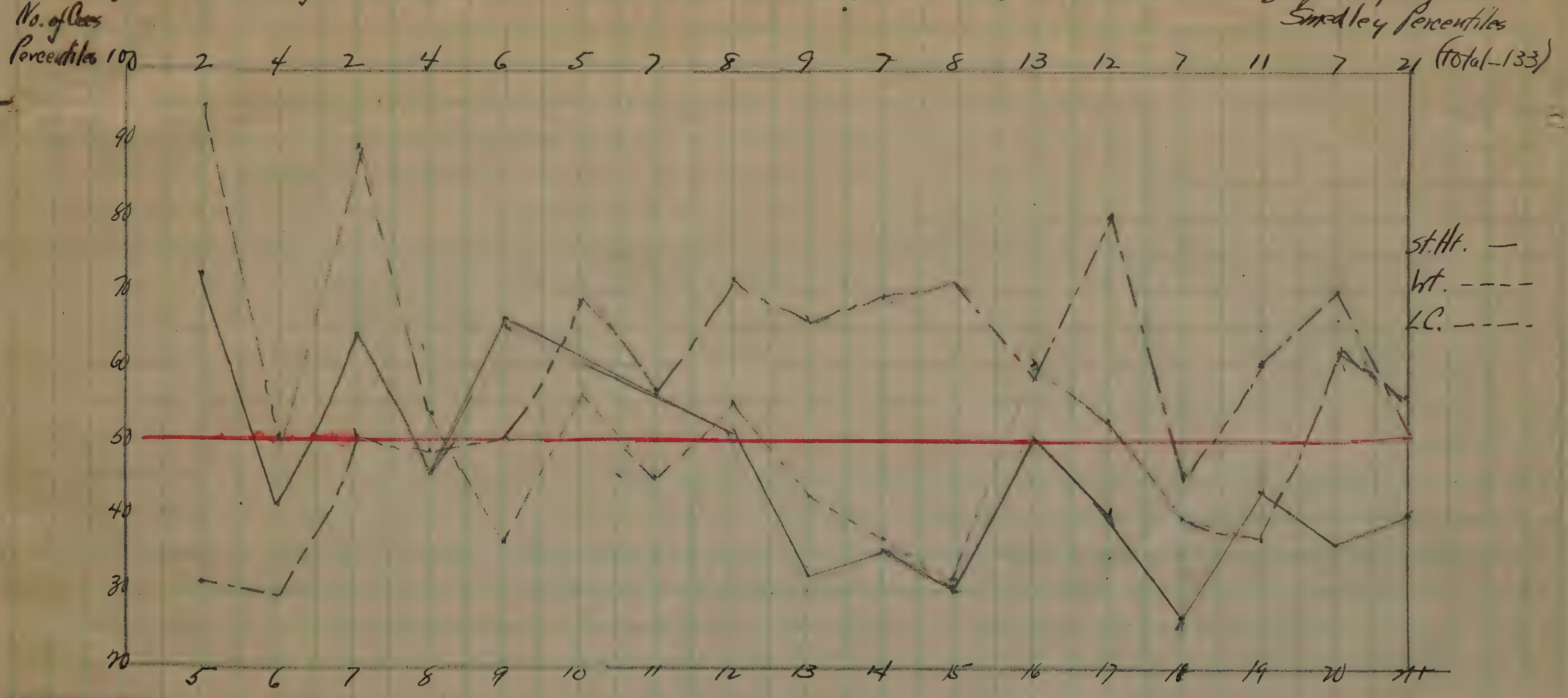
Average Standings of the Boy-Pupils at the Perkins Institution, in Standing Height, Weight and Lung Capacity, by the Smedley Percentiles



Averages of the Boys' Percentiles



Average Standings of the Girl-Pupils at the Perkins Institution, in Standing Height, Weight and Lung Capacity, by the Smedley Percentiles



Averages of the Girls' Percentiles

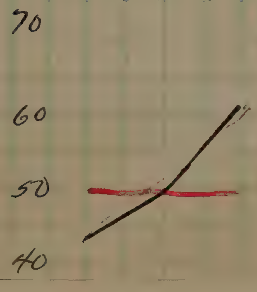
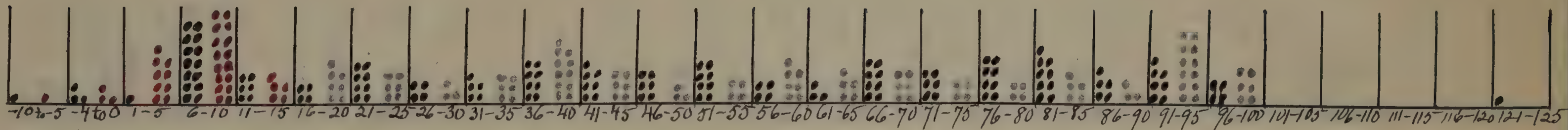
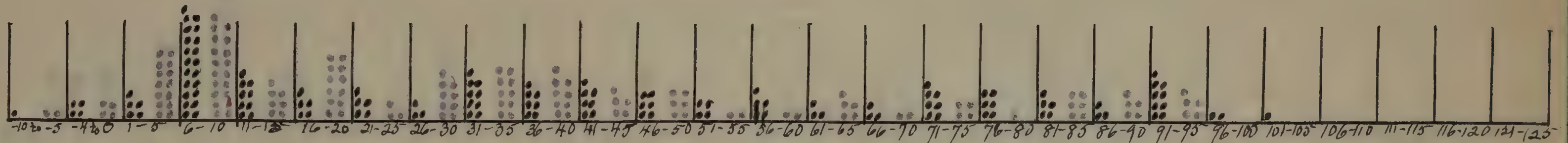


Table III Frequency Distributions, arranged in 5-Percentile Groups Boys ● Girls ●

Standing Height



Sitting Height



Weight

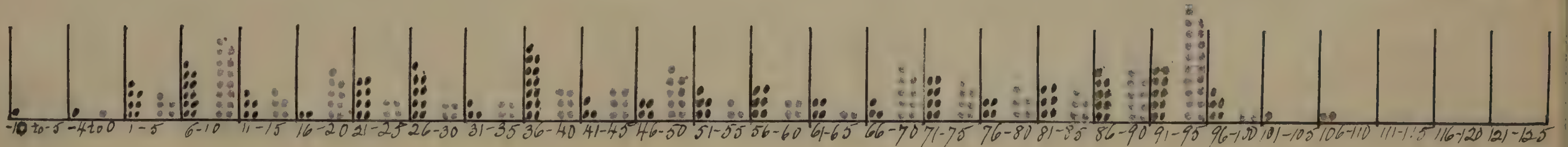
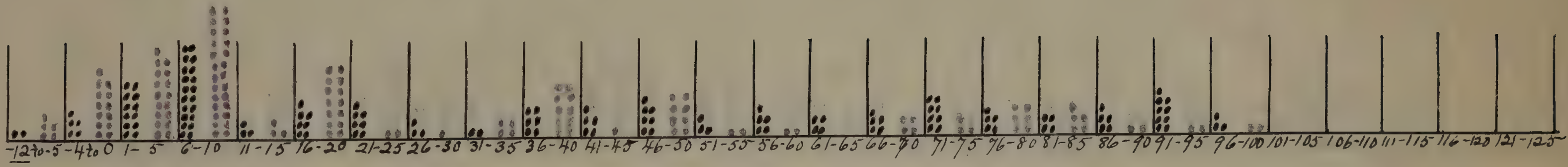
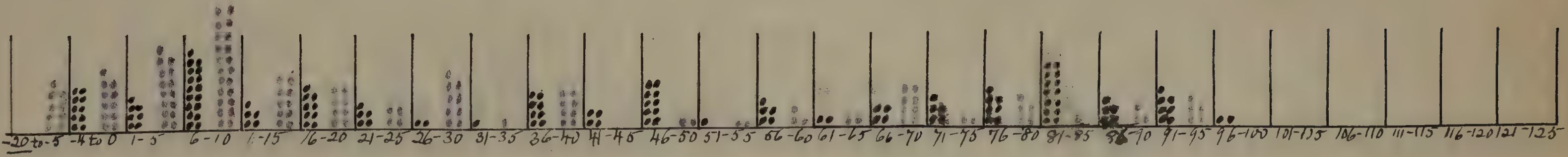


Table III (cont.) Frequency Distributions in 5-Percentile Groups

Right Grip



Left Grip



Lung Capacity

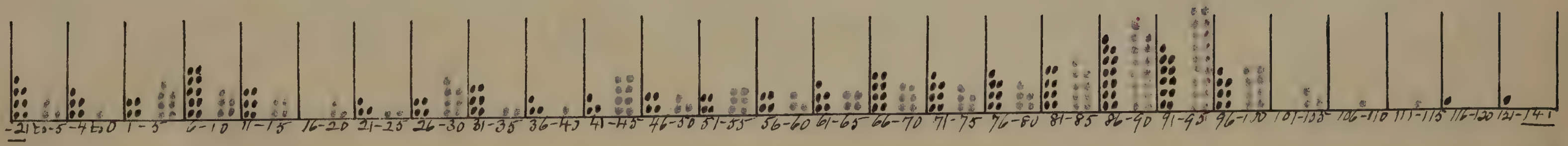
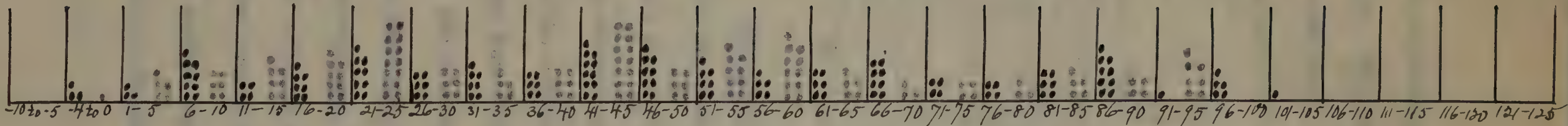
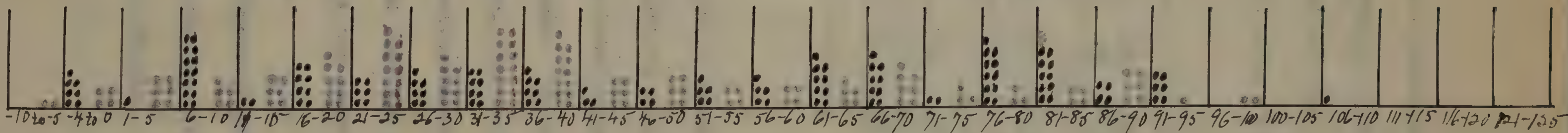


Table III (cont.) Frequency Distributions in 5-Percentile Groups

Physical Averages



Psycho-Physical Averages



a total of 37% of the pupil-population of this school which are at the extremes in weight. Yet the table of averages, (Tables I and II), give the impression that the majority of the boys test around the fifty-percentile, and the majority of the girls at the fifty-one percentile.

Measurements	1-10 Percentile			% of Total 263	31-40 Percentile			% of Total	86-95 Percentile			% of Total 263.
	Boys	Girls	Total		Boys	Girls	Total		Boys	Girls	To.	
Standing Height	15	26	41	16	13	17	30	11	12	15	27	10
Sitting Height	26	33	59	22	14	19	33	12	12	10	22	8
Weight	18	20	38	14	16	10	26	10	19	28	47	18
Right Grip	32	43	75	29	8	14	22	8	14	4	18	7
Left Grip	24	38	62	24	9	9	18	7	12	8	20	8
Lung Capacity	13	12	25	10	9	3	12	5	25	33	58	22
Physical Ave.	13	11	24	9	13	11	24	9	9	11	20	8
Psycho-physical Ave.	14	11	25	10	15	27	42	16	9	8	17	6

Table IV. Samplings of Distribution

Correlations

Since the results obtained from working with averages were so unsatisfactory, it was decided to use correlations only, in finding out what relationship there might be between intelligence ratings and the standings in the different measurements. The correlations were worked out by the Rank-Difference Method. It was decided to do all the correlations for the boys before starting on those for the girls. As was stated earlier, the result was that the corselations for the girls were never done. Table V gives the correlations for the boys when all 130 of them were included.

Although positive results were obtained between the IQ's and all the measurements except weight, none of the correlations was high enought to be of any diagnostic value by itself.

Table V. Coefficients of Correlation between Physical and Psycho-Physical Measurements, and Intelligence Quotients, for All the Boys (120)

Measurements	Standing Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Capacity	Physical Average	Psycho-Phys. Average
Correlations	.14	.22	.−03	.21	.20	.36	.20	.32

Since the results might have been unduly influenced by the measurements of adults and by those of younger pupils who had special disabilities, correlations were found for the ninety-four boys who remained after these had been eliminated. All pupils over eighteen were considered adults. The statistics on special disabilities are scant and unreliable, but the twelve pupils whose disabilities were definitely known were excluded. (Table VIII) The correlations obtained after the elimination of adults and specials are noticeably higher. (Table VI.) The figures for Lung Capacity and Psycho-Physical Average would seem to indicate that they might serve in a supplementary series of tests.

Table VI. Coefficients of Correlation between Physical and Psycho-Physical Measurements, and Intelligence Quotients After Elimination of Special and Adults

Measurements	Standing Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Capacity	Physical Average	Psycho-Phy. Average
Correlations	.28	.35	.23	.27	.38	.44	.27	.41

It happens that the fourteen-year-old boys form a group whose measurements correlate well with each other, and who also happen to be fairly representative of the school as a whole. Since this is

about the age when boys should be starting on another period of growth, we found the correlations between their measurements and their intelligence ratings. The results are noticeably higher, with the exception of the correlation for lung capapcity. (The reason for the .07 there would be interesting to discover.) Nevertheless, even these correlations are not high enough to be of much diagnostic value. This is apparent from a glance at Table VII, where it is seen that the correlations reach .50 only in weight and in right grip.

Table VII. Correlations of Intelligence Quotients of 14-Year-Old Boys(13) with Physical and Psycho-Physical Measurements.

Measurements.	Standing Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Capacity	Physical Average	Psycho-phys. Average
Correlations for 130 Boys.	.14	.22	.-03	.21	.20	.36	.20	.32
Correlations for 13-14 yr. old	.48	.40	.50	.55	.28	.07	.48	.36

Table VIII. Percentile Records and Disabilities of the 12 Boy under 18 omitted from Table

	IQ	St-Ht.	Sit-Ht.	R.G.	L.G.	Wt.	Lung C.	Psy-A	Psycho-P.
IV	110	-1	-3	8	6	5	-11	1	0
	Rickets affecting all measurements, except, perhaps The IQ								
X	87	7	8	73	5	8	-6	29	2
	Pituitary trouble, affecting all measurements								
XXII	84	52	20	58	3	-1	48	43	17
	Partial paralysis of left side, affecting left grip, chiefly								
XXIX	88	9	18	7	3	-3	29	11	10
	Trouble with neck glands. General debility.								
XLVI	54	86	93	98	60	80	14	92	51
	Pituitary trouble, affecting all measurements.								
XVIV	105	68	67	73	75	50	98	69	58
	Explosion, fingers lacking on right hand.								
LV	109	85	89	88	63	9	90	87	54
	Explosion, fingers lacking on left hand.								
LXVII	119	75	33	107	65	60	71	55	65
	Spinal meningitis, affecting height and weight especially								
LXXVII	57	8	14	32	40	83	68	19	64
	Until 2 yrs. before had spent all his time doubled upon floor at home, rocking and twisting feet around neck or fixed Buddha-fashion. All measurements affected.								
XC	103	24	40	75	82	90	96	46	89
	Spinal meningitis, affecting all measurements.								
XCIV	68	95	93	107	91	94	143	98	109
	Probable injury to brain at time of accident which caused blindness, IQ normal at time								
CIII	105	27	38	69	2	16	83	45	34
	Paralysis of hands, affecting right and left grip								

Conclusions

From a study of the tables, the curves of averages, and the frequency table, it is evident:

1. That there is an undue proportion of pupils who test in the lowest percentiles, and

2. That averages and means are not fair criteria of the true standing of the school. The averages all fluctuate around the 50-percentile, thus making it appear as though the pupils at the Perkins Institution compared very favorably with public school children. The mode would be a truer expression of the results, since there is a constant mode appearing in the 1 to 10-percentile group for each measurement. Even the mode would not be satisfactory, however, because some of the measurements have two or more modes, as in the figures for weight.

After carefully studying the data for the purpose of discovering what relationship might exist between intelligence ratings and the standings on the different psycho-physical measurements, the following conclusions were reached:

1. Except in the case of Weight a positive relationship between IQ's and psycho-physical measurements is found.

2. The elimination of the adults and specials raised all the correlations noticeably. In fact, Lung Capacity and Psycho-Physical Average, are high enought to warrant their inclusion in a supplementary series of tes s.

3. The use of the individual curves should be continued until sufficient time has elapsed for it to be known whether those who are nearly normal, mentally, can be made so physically and psycho-physically. It would then be most interesting to find out if improvement in these measurements would mean improvement in accomplishment ability.

Future Work.

It is hoped that, at a later date, the material can be reexmined, with the idea of determining whether or not there is any

connection between standings in right and left grip and vital capacity, and accomplishment ability. If the psycho-physical measurements could be shown to bear some relationship to ability to direct attention to the task in hand and to school grades, there would be on criterion which, although probably not very accurate, could be used as a tentative standard on which to make an assumption in a school of this sort where so many pupils enter at the ages of nine, ten, and even fifteen and sixteen, without having formed any habit of mental industry. A group of the pupils in the lower grades will be worked with, in connection with this problem.

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Special Disability Cases for the Girls.

McCusker, M.	Epileptic.
Hardsimovicz, A.	Probable incipient myxedema.
Dewerger, L.	Right hemiplegia. Possible epilepsy.
Demers, G.	Probable glandular abnormality, resulting in excessive fat and dopiness.
Gilbert, E.	Deformed.
Eastman, A.	One leg much shortened. Severe rheumatism.

Novembe[illegible], 1923.

Note:

We have just figured out the correlations for the girls, using the Otis Correlation Charts. The use of these charts may cause the correlations to vary a few points, but not enough to make any material difference, I think. The results are not what we would hope for from the point of view of simplyfying our results. The easiest way to show the variation between the correlations for the boys and those for the girls is to give two charts here, the first showing the correlations for all the boys and all the girls; the second showing those for the boys and girls after the adults and special disability cases have been removed.

I. Coefficients of Correlation between Physical and Psycho-Physical Measurements and Intelligence Quotients for All the Boys and All The Girls.

Measurements	Standing Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Cap.	Physical Average	Psy.-Phys. Average
Corr. for Boys (130)	.14	.22	-.03	.21	.20	.36	.20	.32
Corr. for Girls (132)	.18	,15	.21	.24	.24	.19	.28	.27

II. Coefficients of Correlation between Physical and Psycho-Physical Measurements and Intelligence Quotients, after Elimination of Specials and Adults, for the Boys and Girls.

Measurements	Standing Height	Sitting Height	Weight	Right Grip	Left Grip	Lung Cap.	Physical Average	Psy. Phys. Average
Corr. for Boys (94)	.28	.35	.23	.27	.38	.44	.27	.41
Corr. for Girls (88)	.18	.11	.21	.26	.28	.12	.21	.25

The correlation for the girls in Lung Capacity is not as high as we expected. Nevertheless it may be that chorus training is the cause for this correlation as well as for the high correlation the boys had, only in a different way. It may be that fewer boys continue to take chorus, and that more of the girls who would naturally have poor lung capacity, continue to take it. Before we can know about this, we will have to get figures as to chorus from Mr. Gardner.

The elimination of the adults and specials for the girls did not affect the correlations as much as it did for the boys. This is probably because of the larger number of accident cases among the boys.

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